

**LIFE HISTORY OF *MAYATRICHIA PONTA* ROSS
(TRICHOPTERA: HYDROPTILIDAE) IN HONEY CREEK, OKLAHOMA**

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Abstract.—The life history of *Mayatrichia ponta* Ross (Trichoptera: Hydroptilidae) was investigated in Honey Creek, Turner Falls Park, Murray Co., Oklahoma, U.S.A. from August 1994 to August 1995. This study provides the first comprehensive life history of a species of Neotrichiini. *Mayatrichia ponta* had an asynchronous multivoltine life history with considerable cohort and generation overlap; five generations were estimated, representing the largest number of annual generations among Trichoptera. The winter generations of *M. ponta* had wider head capsule widths (136–165 μm) than summer generations (121–145 μm). The growth of *M. ponta* was slower in the winter than the summer. The sex ratio of adults was 1.43 δ : 1 ♀ and fecundity ranged from 46 to 150 eggs/female. Fifth instars and pupae aggregated on the bottom side of rocks whereas early instars were distributed evenly on all sides of rocks.

Key Words: *Mayatrichia ponta*, life history, voltinism, fecundity, microhabitat

Trichoptera are a diverse and ecologically important order whose larvae live in a wide range of flowing and standing waters. Hydroptilidae, a species diverse family in the order Trichoptera, account for approximately 19% of all Nearctic trichopteran species. With over 300 species, Hydroptilidae are the second most diverse trichopteran family, surpassed only by Limnephilidae (Morse 1993, 2002). Despite their diversity relatively few detailed studies on the biology of Nearctic hydroptilids have been published. *Leucotrichia pictipes* Banks was reported to be univoltine with an overwintering final instar in Montana (McAuliffe 1982). Resh and Houp (1986) described a univoltine cycle for *Dibusa angata* Ross in Kentucky, with an egg diapause through the summer and autumn and emergence in April and May. More recent studies on Nearctic hydroptilids were by Keiper and Wal-

ton (1999) and Keiper and Foote (2000). Keiper and Foote (2000) described univoltine populations based on field observations in an Ohio stream for *Hydroptila comsimilis* Mosely, *Ochrotrichia spinosa* (Ross) and *O. wojcickyi* Blickle. The biology of Hydroptilidae has been reported in a number of studies in other biogeographical regions of the world. A study of hydroptilids in northeastern Spain, reported univoltine populations for *Hydroptila vectis* Curtis and *Oxyethira frici* Klapalek, bivoltine for *Hydroptila insubrica* Ris, and possibly three generations per year for *Hydroptila martini* Marshall (Recasens and Puig 1991). Wells (1985) reported univoltine and multivoltine populations life cycles for Australian hydroptilids, but gave no details. The biology of several eastern Palearctic hydroptilids has been described (Ito 1988, 1998; Ito and Kawamura 1980). *Palaeagapetus ovatus* Ito

and Hattori populations were reported as having approximately three generations per year while *Eubasilissa regina* (McLachlan) were univoltine (Ito 1988). In another study, Ito (1998) reported populations of *Palaeagapetus flexus* Ito as univoltine and *P. ovatus* as having 3–4 generations in 2 years.

The genus *Mayatrichia* Mosely was first established in 1937 (Mosely 1937). The genus is in the tribe Neotrichiini under the subfamily Hydroptilinae. *Mayatrichia* has six species distributed over North and Central America, and northern South America. Honey Creek in Turner Falls Park, Oklahoma is the type locality for *Mayatrichia ponta* Ross (Ross 1944). The species has also been reported in Texas and Wyoming (Moulton and Stewart 1996). The attenuated head of *Mayatrichia* make their larvae easy to identify in all instars (Wiggins 1996a). There have been no published studies on the ecology and life history of any *Mayatrichia* species or any other Neotrichiini. The purpose of this study is to describe the life cycle and aspects of the biology of *M. ponta* through field studies.

MATERIALS AND METHODS

Study site and sampling.—Honey Creek is a second order permanent limestone stream, originating in the Arbuckle Mountains, and flowing northeastward into the Washita River. The geological formation of Honey Creek changes sequentially from cherty limestone and sandstone to 'Fernvale' limestone and, eventually, to Washita alluvium (Ham 1969). Honey Creek descends from an elevation of 420 m at its origin to 235 m at Washita River (Ham 1969). The most rapidly descending areas are Bridal Veil Falls and Turner Falls. The pH, raised by photosynthetic activity from aquatic plants and algae, causes precipitation of calcium and magnesium carbonates to form thick layers of travertine in the study area (Minkley 1963).

The study riffles were positioned within a 900 m zone upstream of Bridal Veil Falls

in Honey Creek, Turner Falls Park, Oklahoma (34°25.407'N and 97°04.210'W). The upstream riffles were mainly composed of cobbles and pebbles; downstream riffles were mainly composed of travertine substrates with sparse to aggregated stones. The creek width ranged from 15 to 30 m. Riffle depth ranged from 1 to 2 cm in the travertine beds to 20 cm in the cobble substrate under base flow condition. The mean discharge is 1.06 m³/s. The mean pH was 8.0 and the dissolved oxygen was always near saturation. These values were similar to ones reported by Reisen (1975, 1976) suggesting that the water conditions in this stream have been stable over the last 25 years. Water temperature ranged from 9 °C in the winter to 25 °C in the summer during the study period. Air temperature ranged from -6.7 to 41 °C.

Samples of larvae, pupae, and adults were taken from August 1994 until August 1995, weekly from August to September 1994, and biweekly for the remainder of the study.

Adults.—*Mayatrichia ponta* adults were collected with an 8-watt UV light during each field trip. The trap was set approximately one meter from the shoreline near downstream riffles and was operated for one hour after sunset. Flight periodicity was determined from samples taken with aerial nets. Fecundity was studied by dissecting field-collected females, and lab-reared females when no field collected adults were available.

Larvae.—Samples indicated that the majority of *M. ponta* larvae were found on rocks greater than 15 cm across that were resting on the travertine stream substrates. On each sampling date six rocks ranging from 15 to 30 cm in diameter were collected along a randomly chosen transect across the stream. The upper size limit was established based on our ability to handle and process the material in the field. Organisms and debris on the surface of the rock were brushed into a bucket filled with filtered stream water. The contents of the bucket

were then passed through a sieve to concentrate the sample. A 150- μm sieve was initially used for collections in August 1994; for subsequent sampling a 38- μm sieve was used to collect the earliest instars. Collected materials were preserved in Kahle's solution then stored in 80% ethanol until processed in the laboratory.

Head capsule width and length were measured using an Olympus SZH dissecting microscope coupled with an Olympus CUE-2 image processing system. Instars were separated by a scatter plot of head capsule width against head length. The prominent sclerites of the fifth instar also were used to help distinguish instars. The length of the head capsule (HCL) was measured from the anterior margin of the frons to the posterior margin of head sclerites. The width of the head (HCW) was measured as the distance of the head capsule across the eyes.

Diet examinations of larvae were determined from collections made during July 1996. Freshly collected larvae were relaxed in carbonated water for 5 minutes to reduce regurgitation of the gut contents and then preserved in ethanol. Fore- and midguts were dissected, placed in glycerin on a microscope slide, and scanned under a compound microscope with 800–1,000 magnification. The proportion of each component of the diet was quantified by relative percentage of area.

Larval microhabitat.—The effect of water current on the spatial distributions of *M. ponta* larvae and pupae on each surface (top, bottom, front, back, left, and right) of individual rocks was examined in March 1996. This sampling occurred during a period with high numbers of larvae and pupae were present. Prior to each biological sampling, water flows were estimated in front of individual rocks by a Pygmy flow meter and on each rock surface exposed to water current using a modified Gessner current meter (Hynes 1970, Wallace 1975). After measuring currents, each rock surface was brushed, and the contents were concentrat-

ed in a sieve (38 μm) and preserved with Kahle's solution in separate bottles. Larvae were sorted to instar and counted in the lab. The area of each side of each rock was measured using the aluminum foil weight-area method described by Doeg and Lake (1981).

Counts of each instar and pupae on each side of each rock were converted to a standard density, number of individuals/0.01 m^2 . This area was selected because it approximates the mean surface area of all stones collected. Both population size and surface area data were normally distributed (Shapiro-Wilk test for normality, $\alpha = 0.05$). A one-way ANOVA was used to test if the means of current velocities on six sides were significantly different. A Pearson Correlation Analysis was used to determine the coefficient between the population size of *M. ponta* and surface area of substrates. A one-way ANOVA was also used to examine the mean densities of each instar on the six sides. The Student-Newman-Kuels multiple comparison test was used to determine statistically significant differences between means. All statistical analyses followed Zar (1984) using SAS software (1991).

Rearing.—Live larvae and pupae were transported to the laboratory and placed in aquaria containing natural substrates and aerated stream water for rearing. Pupae were reared individually for association with adults. Behaviors were observed in these aquaria. Larval behaviors were also observed under a dissecting microscope.

The overall behavior, fecundity, life cycle, voltinism, and life history of *M. ponta* were interpreted from information gathered by the field activities described above and laboratory observations. Voucher materials, including representatives of all life stages, are deposited in the University of North Texas Elm Fork Natural Heritage Museum.

RESULTS AND DISCUSSION

Eggs.—Despite numerous attempts, we were unable to induce oviposition in females collected in the field or reared in the

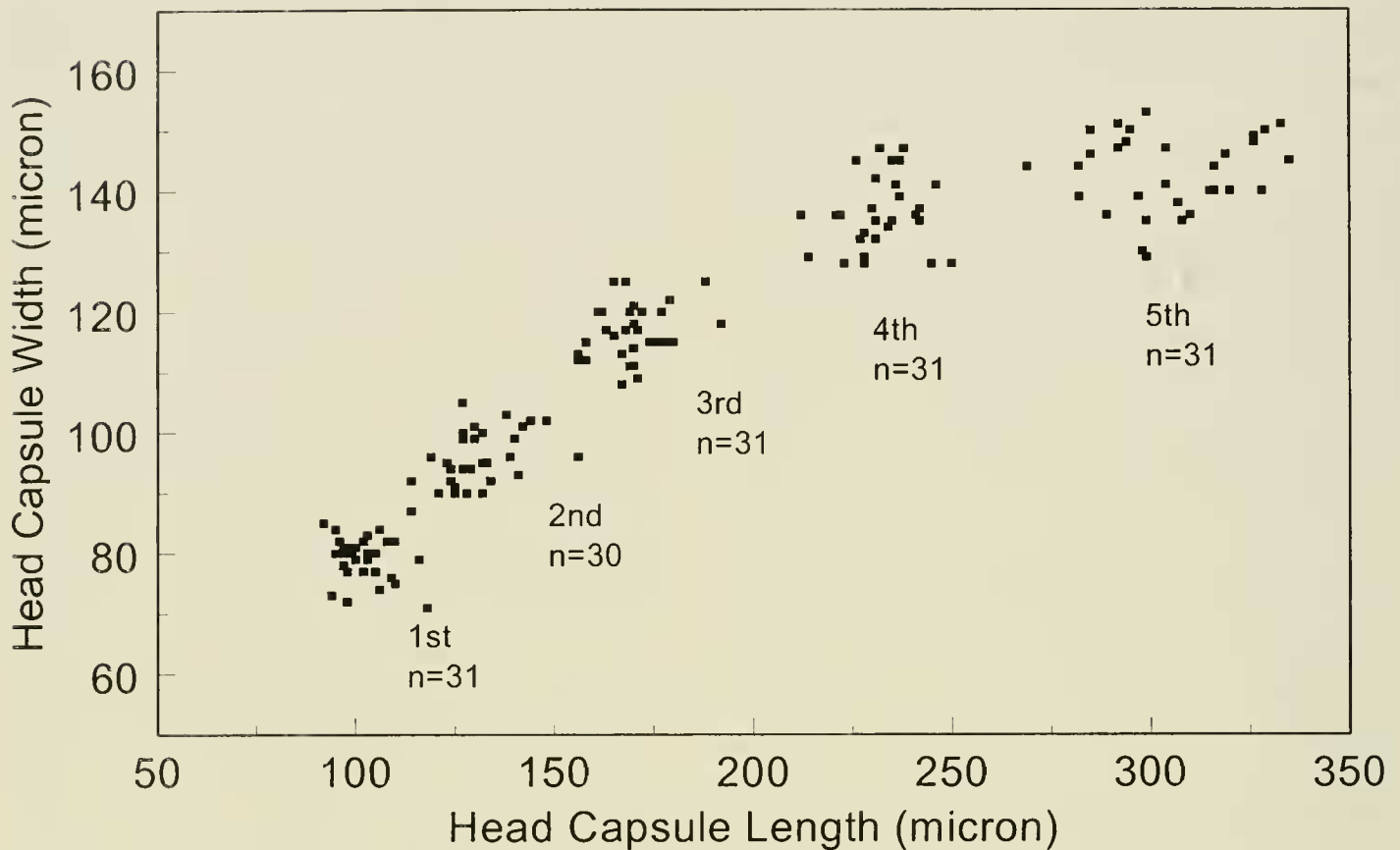


Fig. 1. Scatter plot of *Mayatrichia pontae* head capsule width versus length illustrating instars.

lab. However, female *M. pontae* taken in light traps often released egg masses when they became immersed in preservative. These egg masses were contained in a light yellow gelatinous fluid. The diameter of eggs in female abdomens was 52–76 μm (\bar{x} = 65 μm , n = 8). Eggs of *Agraylea multipunctata* Curtis and *Oxyethira costalis* Curtis, were also reported to be in a gelatinous mass (Nielsen 1948). However, *D. angata* laid eggs singly (Resh and Houpp 1986), indicating that oviposition strategies vary among the Hydroptilidae.

Larval distribution.—Instars were separated by a scatter plot of head capsule width against head capsule length (Fig. 1). Five instars were determined for *M. pontae*, which is typical for Hydroptilidae (Nelson 1948).

Nearly all larvae of *M. pontae* were found on or under rocks. However, a few 5th instar larvae were found under moss mats beneath fast flowing water and in abandoned black-fly pupal cases. A one-way ANOVA showed significant difference in flows

among the six sides of rocks (n = 10, α = 0.05, P = 0.0001). The populations on the bottom side of the rocks were separated as a distinct group from those on other surfaces (Student Newman Kuels test, α = 0.05). The top surface had the highest mean flow of 32.4 cm/s (SD = 10.9 cm/s).

Densities of instar I through IV on the six surfaces of rocks were not significantly different. However, densities of fifth instars and pupae were significantly greater on the bottom of the rocks than other sides (Student Newman Kuels test, α = 0.05). These observations suggest that instars I–IV of *M. pontae* are dispersed evenly on all surfaces, but final instars preferred the bottom surface where low flows occurred. These shifts in microhabitats are similar to those reported for *Hydropsyche pellucidula* Curtis (Boon 1979, Muotka 1990), and *H. angustipennis* Curtis (Muotka 1990).

Diet.—Wiggins (1996b) indicated that *Mayatrichia* species are scrapers. Examination of 13 full larval midguts found that all gut contents were 100% unidentifiable

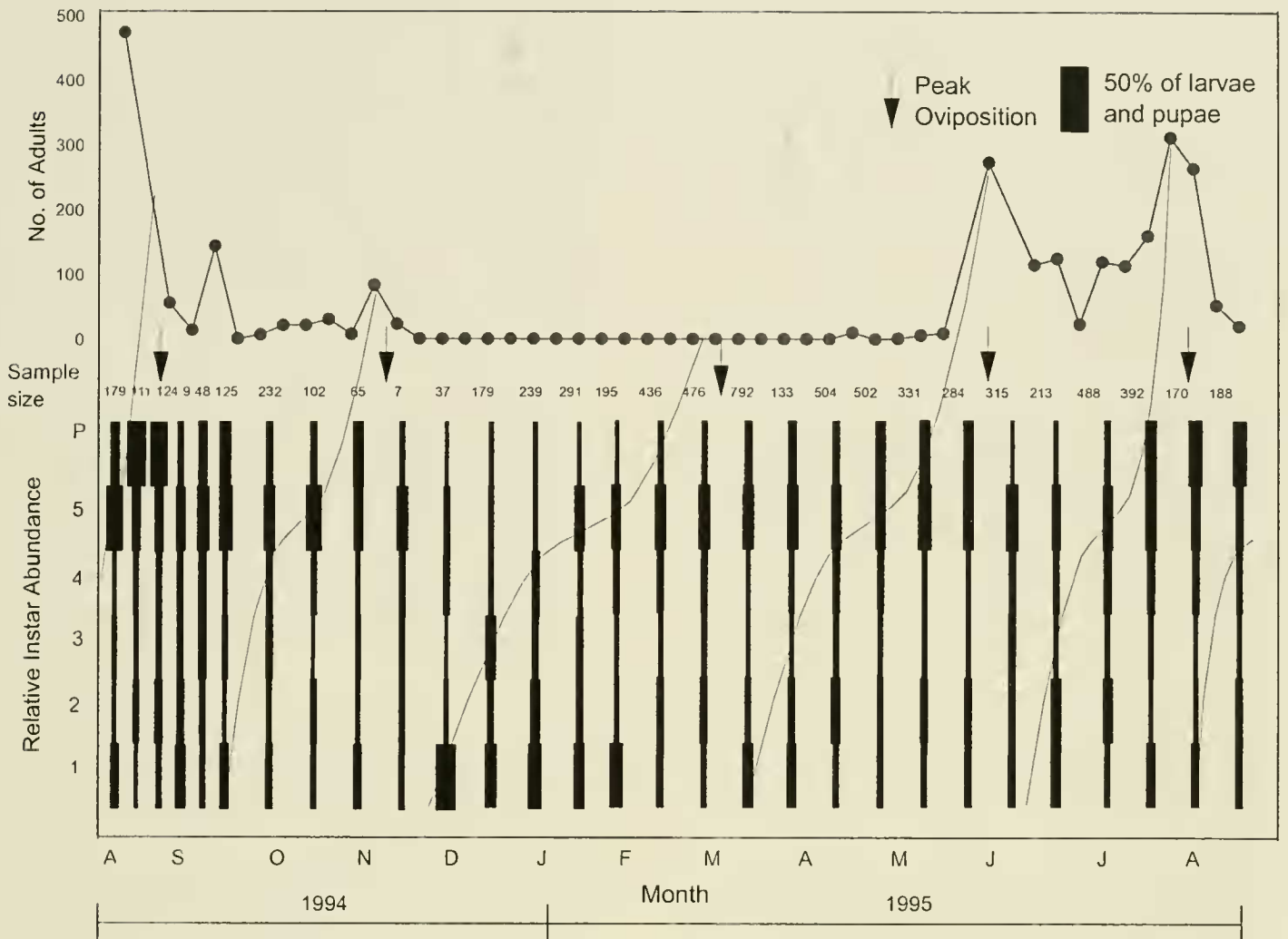


Fig. 2. Relative abundance of instars, pupae, and adult abundance of *Mayatrachia ponta* from August 1994 through August 1995. Width of bars indicates relative percent of each instar or pupae represented. Each cohort is indicated by a curved line and peak oviposition by arrows.

detritus. However, most larvae collected had bright green abdomens, suggesting that periphytic algae is included in the diet. The attenuated head capsule may be associated with specialized feeding habits (Wiggins 1996a), and it may be that the larvae are piercing individual algal cells, ingesting the contents and discarding the cell walls. This type of feeding has been observed in other hydroptilids (Ito 1998, Keiper and Foote 2000).

Emergence and flight periodicity.—Adults were collected in light traps from April through November (Fig. 2). The sex ratio of 2,482 adults collected during this period was 1.43 ♂: 1 ♀. Adults were not collected in light traps from December through March. However, adults were

found in grass along the shoreline throughout the year.

Emergence behavior was observed in the laboratory. During emergence the adult came to the water surface without the pupal exuviae. Upon breaking the surface tension, they rode on the surface for a short distance before climbing onto substrates. Newly emerged adults were soft and white.

Fecundity.—Fecundity was estimated by counting eggs from the dissected abdomens of preserved females. The number of eggs per female was 32–150 (\bar{x} = 86, SD = 31, n = 50). The fecundity of *M. ponta* is slightly lower than that reported for other hydroptilids, such as *Agraylea multipunctata* Curtis, with 120–300 eggs, *Oxyethira costalis* Curtis, with 150–170 eggs, and *Or-*

thotrichia tetensii Kolbe, with 90–210 eggs (Nielsen 1948). Trichopterans having this range of fecundity are *Agapetus bifidus* Curtis, with 30–100 eggs (Anderson and Bourne 1974), *Agapetus fuscipes* Denning, with 12–94 eggs (Anderson 1974), and *Cuiloptila cantha* Ross, with 45–120 eggs (Houghton 1996).

Volitinism.—Larvae of *M. ponta* were found in abundance year round, except after floods. Correlation of instar occurrence with pupal population and emergence permitted an interpretation of the life cycle. A multivoltine life history was exhibited by *M. ponta*, with two summer, a fall, winter, and spring generations (Fig. 2). Cohort asynchrony and generation overlap appeared in the life cycle. Asynchronous life cycles also appear in other hydroptilids (McAuliffe 1982, Recasens and Puig 1991, Resh and Houpp 1986). Delayed and asynchronous egg hatching probably contributed to the asynchronous life cycles. The fast molt rate in early instars and long duration in the last instar caused last instar larvae and pupae to be represented more often in the population.

A large emergence and high pupal densities were found in the initial samples taken in early August 1994, marking the end of a summer generation. Sampling began too late to define the beginning of this generation (Fig. 2). Decreases in larval and pupal populations were observed at the beginning of September and again in early November. Floods, sufficient to move rocks 20–30 cm in diameter, occurred prior to each of these dates. The travertine stream bed does not provide a hyporheic refuge. It is thought that during floods most organisms are catastrophically swept away. Despite air temperatures suitable for flight activity, reductions in *M. ponta* emergence were also noted in samples taken following flood events.

A fall generation began in September, developed to last instar in mid-October, and emerged in early November. The winter generation started in mid-November, devel-

oped to last instar in January, and began adult emergence in early March. The prolonged occurrence of high densities of early instars and low late instar densities suggested slow development. The asynchronous emergence period of the winter generation was prolonged from early through mid-March, based on high fifth instar and pupal densities in March. The slow development of the winter generation led to larger body size of respective larval instars. Mean head capsule width for winter generations of fifth instar *M. ponta* was 138 μm (136–165 μm) compared to 131 μm (121–145 μm) for the summer generations. The end of the winter generation was estimated to be in early March, based on the following observations: First, despite the fact that adults were not caught in light traps because of low temperature, aerial net collections indicated emergence of *M. ponta* occurred in early March; second, a sudden increase of early instars densities in mid-March suggested emergence and oviposition occurred before this date (Fig. 2) and; third, the degree days accumulation based on air temperature reached 1,100 in early March, which is similar to that observed for a warm season population to complete a life cycle. The relationship between air and Honey Creek water temperature was significantly correlated (Pearson Correlation analysis on ranked data, $n = 40$, $r^2 = 0.86$, $P = 0.0001$).

The spring generation started from eggs oviposited in early March and emerged in late May. The larval development rate increased with rising water temperature. An early summer generation, developing from May through mid-July, followed the spring generation. Temperature is an important factor regulating growth rates of aquatic insects (Grafius and Anderson 1979, Ward and Stanford 1982, Sweeney 1984), and was probably responsible for the long duration of the *M. ponta* winter generation and shorter generations in warm seasons. It has been reported that seasonal temperature changes may also synchronize life cycles

(Williams 1991). However, the life cycles of *M. ponta* remained asynchronous throughout the study.

The five generations a year of *M. ponta* is the highest reported for any trichopteran (Wallace and Anderson 1996). The life histories of other hydroptilids were reported as univoltine in North America (McAuliffe 1982, Resh and Houpp 1986, Keiper and Foote 2000). European hydroptilids have been variously reported as univoltine or multivoltine (Nielsen 1948, Recasens and Puig 1991). Ito (1988, 1998) reported univoltine and multivoltine populations for Japanese hydroptilids. Voltinism variations within the same family are well recognized. Species of Glossosomatidae (Anderson and Bourne 1974, Georgian and Wallace 1983) and Hydropsychidae (Mackay 1979, Parker and Voshell 1982) have been reported to have different voltinisms even under the same thermal regime. Additional studies of life histories of Nearctic Hydroptilidae, especially those occurring in warm climates, are needed to understand how the life cycle of *M. ponta* compares to them.

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